The Study of The Tight Sandstone Reservoir’s Characteristics and The Fluid Inclusions in Fuyu Oil Layer, Daqing Placanticline

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1 Introduction

The exploration and development of unconventional oil and gas is gradually becoming the new hot topic, which is promoted by the increasing demand of oil and gas, as well as the decline in conventional oil and gas production (Jia et al., 2012; Zou et al., 2012). The researches of unconventional oil and gas resources started late in China, while the resources are widely distributed, including abundant resources of unconventional oil and gas in the Cretaceous Qingshankou - Quantou formation in Songliao basin (Zou et al., 2012). The characteristics of tight sandstone control the ways of storage and the occurrence state of the unconventional oil and gas (Song et al., 2015; Lai et al., 2014). This article is aiming at revealing the characteristics of the hydrocarbon accumulation and the tight sandstone reservoir, as well as promoting the further investigation of tight oil geology, by taking the tight sandstone as research target.

2 Geological Background

Daqing placanticline is a secondary tectonic unit that belongs to the central depression area in northern Songliao Basin. The tectonic unit has the overall trend of North North East, and the characteristics of the narrow northern part and wide south part(Meng et al., 2010). The sandstone reservoirs in Fuyu oil layer are mainly tight reservoirs, and secondly are conventional reservoirs (Jia et al., 2012; Zou et al., 2012; Song et al., 2015). The paleo-climate was transforming from semi-arid to moisture during the deposition period of the 3 to 4 member of Quantou Formation sedimentary period, and developed the sedimentary systems of meandering river, braided river and shallow water delta, typically characterized by the development of meandering river course and crevasse splay sediments. The distribution of the sand bodies is controlled by the sediments’ sources from southern and northern direction.

3 Samples and Methods

Thin section observation, casting image and scanning electron microscopy (SEM) analysis were carried on tight sandstone core samples. The multi-function microscope and cooling-heating stages are used to analysis the secondary inclusions, and the inclusions analysis were completed by Julien Bourdet in the Australian Academy of Sciences.

4 Results

4.1 The characteristics of reservoir petrology

The rock types are mainly feldspar lithic sandstone and lithic feldspar sandstone. Feldspar debris is mainly plagioclase, the content of potassium feldspars are second. Quartz is mainly single crystal quartz, with most of them developed overgrowth quartz. Rock debris is mainly granite debris, then is sedimentary and phylite debris. Reservoir sandstones mainly have the medium to fine grain structure, and poor to medium sorting. The cement is mainly calcite. Petrographic analysis shows that the overgrowth quartz predate calcite, and the forming of calcite predate the dissolved intragranular pore of feldspar. The bitumen filled the reservoir before the formation of calcite cement. Hydrocarbon inclusions, gas-brine-hydrocarbon inclusions and hydrocarbon-bearing brine inclusions are developed in the healing fractures of quartz and overgrowth quartz.

4.2 The types of reservoir pore

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The types of reservoir pores are mainly primary pores, secondly, are secondary porosity. Primary pores are polygonal and triangle pores, secondary pores are mainly dissolved intergranular and intragranular pores.

4.3 The characteristics of the reservoirs’ physical property

Physical conditions and the pores’ distribution of reservoirs are mainly the result of mutual influence between the deposition and diagenesis. The sedimentation controls the reservoir features, macroscopically, such as the shape, scale and distribution of reservoir. And by controlling the reservoirs’ rock type, the fabric, the content of filling control, and other factors, the sedimentation controls the initial conditions of reservoirs and the ability of anti-alteration during the late stage. Diagenesis is mainly influence the evolution of the reservoir at the micro scale. The reservoirs’ type of dense I are widely distributed in the study area, according to the evaluation criteria of dense oil that proposed by Jia (2012).

4.4 The characteristics of inclusions

The hydrocarbon inclusions developed in the quartz’s fractures, feldspars and carbonate cements, showing white, blue, and yellow fluorescence colors. The development of the hydrocarbon inclusions were accompanied with the filling of the bitumen. The content of the brine inclusions are less. The lowest capture temperature of the inclusions is about 90°C, and the inclusions were captured from the high salinity fluids (56000–69000ppm). The bitumen and inclusions were both the production of the injection of oil and gas. The formation of bitumen was related to the deasphalting process of heavy oil or gas. The formation of some carbonate cements were influenced by the bitumen. Both the oil inclusions and brine inclusions have the same homogenization temperature, meaning that the inclusions generated from the fluids saturated with gas.

5 Discussion

The ancient fluid that preserved in the inclusions provides the important information of the injection intensity of oil and gas, the filling periods, and the mineral dissolution and precipitation in the oil-water coexistence system. The process of oil and gas migration and accumulation can be inversed evaluating based on the research of the characteristics of hydrocarbon inclusions (Song et al., 2015). Most researchers take the homogenization temperature peak value of brine inclusions as the basis of hydrocarbon filling periods. But due to the oil and gas inclusions capture is conditioned by many factors, it is apparently not convincing that determining the hydrocarbon filling periods by the test results of small amount of samples. In this study, the homogenization temperatures of bring and oil & gas inclusions in cracks quartz, feldspar and carbonate were comparatively analyzed. The results show that the homogenization temperature between oil and gas inclusions and brine inclusions are the same, and the lowest capture temperature is 90°C. The first period of oil and gas was injecting continuously into the object layers. At the same time, the oil inclusions were found in the overgrowth quartz, suggested that quartz cementation was carrying on in oil-water coexistence system.

6 Conclusions

(1) The rock types of reservoir are mainly feldspar lithic sandstone and lithic feldspar sandstone, and diagenetic sequence is quartz overgrowth - reservoir bitumen - calcite cementation - feldspar dissolution.

(2) The types of Pore are mainly primary pores, followed by secondary pores. The Dense I reservoir are widely distributed.

(3) The first period of oil and gas was injecting continuously into the object layers. The lowest capture temperature of inclusions is 90°C, which formed in the fluid condition of high salinity water and saturated gas. The formation of the bitumen is related to the deasphalting of heavy oil or gas, meanwhile the formation of some carbonate minerals are related to the bitumen in the reservoir.

Reference


